Use of Simple Analytical Checks and Avoiding Unnecessary Financial Jargon

Discussion of blunders that were made in the lead up to the financial crisis has not yet mentioned those complex toxic securitized investments that many people claim were a big cause of the crisis because they are just too difficult to analyze. During the financial crisis, experts regularly appeared on television programs and used fancy financial language that and discussed credit default swaps, multiple debt tranches, structured investment vehicles, collateralization, systematic risk and many other sophisticated terms. Films and books on the financial crisis made it seem that all of this finance business was just too complicated for the average layperson to comprehend. Suggestions were made that the sophisticated securities should be outlawed or heavily regulated because they were too difficult to analyze. People who read a little about the crisis would proudly explained how mortgages were put together into a structured finance instrument and then cash flows of that thing would be distributed to different investors. The complexity of modeling is noted as follows: "The problem is that these instruments have become so incredibly complex that you need incredibly sophisticated computer models to work out their value."

The root of the financial crisis was the bubble in house valuation combined with bad lending practices at an individual loan level. The key to understanding what went wrong is understanding these fundamental economic issues and not going through a thirty page financial model. Sudden declines in the value of the complex CDO securities is not difficult to grasp once the economics of the underlying assets such as subprime loans measured. To demonstrate problems in valuation of loan packages, you did not need some highly elaborate financial model. Instead, a relatively simple structured finance model discussed in the next couple of paragraphs can demonstrate the problems with the so-called toxic investments and verify that the top-tier debt was not all that safe. This failure to check seemingly complex analysis with basic cash flow models was a further analytical mistake made in the financial crisis. Similar failures to perform relatively simple analysis that demonstrated problems with business concepts are present in just about all of the case studies discussed in subsequent chapters.

One explanation of the collateralized securities that is enough to set up a financial model is the following: "Mortgages were transferred to a trust and then sliced or tranched horizontally into different segments, with different bonds for each segment. The trick was that the top-tier bonds, which represented say 70 percent of the value sold had first claim on all cash flows. Since it is inconceivable that 30 percent of a normal mortgage portfolio can default, top-tier

bonds go triple-A, super safe ratings and paid commensurately low yields."[1] In terms of making a financial model, the bonds can be modeled as a cash flow sweep given that these bonds had the first claim on cash flows. Modeling this financial structure involves setting-up a debt schedule and connecting repayments to the assumed cash flows generated from mortgages.

After the financial crisis began, the effect of increasing defaults on the risk of a collateralized security was described in the context of defaults: "When the sub-prime CDO market first took off in 2005, sub-prime mortgage defaults were only 3%. A 20% cushion of equity and subordinated debt seemed like ample protection, so rating agencies generally assigned triple A to the top 80 percent of bonds in the CDO. Actual default rates were more than 10% and rising." [2] Default rates on individual loans that were much higher than 10% were very predictable, albeit with hindsight, from the combination of large decreases in housing prices, high loan to value ratios and the unlikeliness that people who have underwater mortgages will continue to honor loan contracts. Developing a financial model with different default rates, losses after default and interest income proceeds from the original loans can be structured as the source of cash flow, much like rental proceeds on a commercial building. With assumptions made for cash inflows from mortgages, the construction of a simple financial model that can evaluate what happens when the probability of default changes as suggested by the above quote along with rising loss given default rates.

One of the failings in many financial analyses and financial models these days is the problem of falling into a financial jargon trap without developing a simple way to verify the riskiness of an investment. To understand how CDO's worked and what happened to their value when defaults trended upwards, a relatively simple financial model with a cash flow waterfall can be built. You do not have to construct a whole lot of different sheets or to incorporate complex stochastic equations. You simply need to know how to use the minimum function in excel spreadsheet and, more importantly, organize your thinking and your model in a logical and structured manner that reflects how the loans will be repaid. The model organization should separately emulate how the sub-prime money inflows arise and where that money goes. You begin with a few assumptions about the interest rate received on the subprime debt and the interest rate paid for top-tier bonds. In modeling how much money is received, you also need inputs for the probability of default and the loss given default. Once you create a model and think about scenarios where housing prices fell below the value of loans and where people did not make contract payments, you can use the model to see that

[1] Jones, Sam, "The formula that felled Wall St", April 24 2009, The Financial Times Limited 2009, http://www.ft.com/cms/s/2/e3b972fc-3aa6-11de-8a2d-00144feabdc0.html

[2] Tett, Gillian, How panic gripped the world's biggest banks, May 8 2009 http://groups.google.com/group/misc.invest.stocks/browse_thread/thread/bc3ea42a6f0acd25

the top-tier bonds were not really that safe at all. You do not have to be an expert in systematic risk, collateralization or credit default swaps.

If you want to see the details of how the models are constructed, you can go to the associated website www.edbodmer.com and watch a YouTube video that works through the model on a line by line basis.[3] As the length of the video explaining how to build the model from scratch is less than half an hour, you will hopefully agree that the model is not some kind of highly complicated analysis that only a few highly paid financial experts could construct. Figures 2.9 through 2.12 demonstrate parts of the simple structured finance model. The model begins with laying out assumptions for timing inputs, cash flow sources from sub-prime loans and default statistics. Assumptions for financing the structured finance vehicle is included after the inputs for the cash inflows. After setting-up the assumptions, the financial structure is presented in terms of a sources and uses of funds analysis. A key part of the model is computing the revenues realized from subprime mortgages after accounting for defaults and recoveries of loans that are not paid. This is just like any other financial model where the most important element is modelling revenues, expenses and capital expenditures.

With cash inflows established, the financing structure can be developed. This involves first structuring the balance of the top-tier debt and then connecting the repayment of the debt to a cash flow waterfall. The cash flow waterfall puts various parts of the model together. Cash inflows from the subprime mortgages are put on top of the waterfall. Then the cash flow is used to the maximum extent possible to pay off the top-tier debt through displaying some cash flow sub-totals and using the minimum function in excel (paying the lesser of the available cash flow or the beginning debt balance). Once the top tier debt is paid, the remaining cash flow is paid to the equity investors. The final part of the model computes the cash flows to the debt and equity investors and computes the IRR on the cash flow. If the IRR on the top-tier debt is below the stated interest rate, then a loss on the top-tier debt has occurred. Multiple different tiers could easily be computed for different structures by using the minimum function for each tranche.

Figure 2.9 shows how the assumptions are laid out in the simple CDO model. Some of the assumptions for the financial structure of the investment are on-time inputs that are constant over time. Other assumptions that can vary over time are shown on a year-by-year basis. The only assumption that is difficult to get your hands around is probability of default. If a probability of default of 15% per year on subprime is assumed, more than 50% of the loans default on a cumulative basis by year 5. The scenario shown on Figure 2.9 assumes a default rate of 5% for 4 years followed by the assumed stable default rate of 2%. By year 30, this results in a cumulated default rate of 48%. When presenting the model, years 1 through 5

[3] The modeling techniques are documented in book Corporate and Project Finance Modeling, Theory and Practice. Bodmer, Edward.

and years 25 through 30 are displayed in order so that the model can fit on a page. Statistical analysis on historic default rates can be interesting, but it did not provide any insight with respect to realistic default rates. Assumptions shown in Figure 2.9 are hidden for the middle periods of the model.

Financial Structure Assumptions												
Amount of Subprime Loans	1,000.00			Project IRR	4.56%							
Loans/Equity	5			Equity IRR	5.91%							
Equity to Assets	20%			Debt IRR	3.50%							
Fees	7.00%											
Subprime Repayment Years	30.00											
Years of High Default	4.00											
Stable PD	2.00%											
Annual Assumptions		1	2	3	4	5	25	26	27	28	29	30
Rate Charged on Sub-prime Loans		6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%	6.50%
High Default Period		TRUE	TRUE	TRUE	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE
PD		5.00%	5.00%	5.00%	5.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%	2.00%
Cumulative Loans Current	1.00	95%	90%	86%	81%	80%	53%	52%	51%	50%	49%	48%
Cummulative Default Percent		5%	10%	14%	19%	20%	47%	48%	49%	50%	51%	52%
LGD		30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%
Delay in Recoveries		2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Interest Rate on Top-tier Debt		3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%	3.50%

Figure 2.9 – Set-up of Assumptions in Simple Structured Finance Model

After the assumptions are developed, the sources and uses can be reported as shown in Figure 2.10. The sources and uses analysis is like a mini balance sheet and for the simple model it shows how much money is spent to buy subprime mortgages and to pay all of the fees to various parties. After compiling the amount spent, the amount to money coming from various sources and invested in the venture is displayed. A sources and uses statement is presented for each of the project finance cases in subsequent chapters. If equity is input into the project and the top-tier debt is reduced, the investment can absorb defaults and losses on default while still being able to fully repay the debt. If less equity is in the sources of funds, there is less buffer before which losses on the top-tier debt is realized. Figure 2.10 assumes 20% equity corresponding to the example cited above. A lot about the structured investment can be understood by looking at this simple little statement.

Part 1: Sources and Uses of Funds

Uses of Funds	Amount	Percent
Purchase of Subprime Debt	1,000.00	93.46%
Fees	70.00	6.54%
Total Uses	1,070.00	100.00%
Sources of Funds		
Top-tier Debt	856.00	80.00%
Equity	214.00	20.00%
Total Sources	1,070.00	100.00%

Figure 2.10 – Sources and Uses of Funds in Structured Finance Model

After the sources and uses, the next part of this, or any other, model derives the cash inflows that are earned by the investment and that will be used to pay off the debt and equity that pay for the assets. For the subprime debt, the cash flow depends on three items. First, the debt service paid by homeowners is computed from the sub-prime loan interest rate with the interest rate increases, the prepayment fees and so forth. Next, the debts are adjusted for the amount of interest that is not paid because of default. Finally, the amount of recoveries is incorporated using the loss given default assumption. The cash inflow table that depends on the non-defaulted debt is shown on Figure 2.12. The example in Figure 2.11 shows that by the end of the mortgage the total loan balance is repaid. Recoveries of loan defaults are assumed to occur three years after the default occurs.

Part 2: Cash Flow Inflows from Subprime Assets												
Balance of Subprime Debt and Cash Inflw		1	2	3	4	5	25	26	27	28	29	30
Opening Balance		1,000.00	968.65	937.44	906.33	875.31	279.67	237.68	193.97	148.46	101.03	51.59
Less: New Defaults for Year		20.00	19.37	18.75	18.13	8.75	2.80	2.38	1.94	1.48	1.01	0.52
Less: Repayment of Loans		11.35	11.84	12.36	12.90	13.60	39.20	41.33	43.57	45.94	48.44	51.07
Closing Balance	1,000.00	968.65	937.44	906.33	875.31	852.95	237.68	193.97	148.46	101.03	51.59	0.00
Interest Income		65.00	62.96	60.93	58.91	56.89	18.18	15.45	12.61	9.65	6.57	3.35
Recoveries from Defaults												
New Defaults		20.00	19.37	18.75	18.13	8.75	2.80	2.38	1.94	1.48	1.01	0.52
Recovered		14.00	13.56	13.12	12.69	6.13	1.96	1.66	1.36	1.04	0.71	0.36
Delayed Recoveries		FALSE	FALSE	FALSE	14.00	13.56	2.77	2.51	2.24	1.96	1.66	1.36

Figure 2.11 – Cash Inflows from Sub-prime Loans in Structured Finance Model

After the cash inflows are established, a table of the debt repayments should be constructed. The debt schedule always lays out the opening balance, how the debt is repaid and the interest expense. For this model, the repayment of debt comes directly from the available cash flow that is computed in the cash flow waterfall. A provision for non-payment of interest expense is also incorporated in case the cash flow is not even enough to pay the interest. The amount of interest

that cannot be paid also comes from the case flow waterfall. Figure 2.12 displays the part of the model for both the debt schedule and the cash flow waterfall. The only formula that is in the least bit complex are the formulas for debt repayment and for the defaulted interest. These formulas must consider whether the cash flow is negative or positive as well as the maximum level of the default. In the example shown in Figure 2.12, the debt is fully repaid by year 25 meaning the dividends can then be paid to equity.

Part 3: Debt Repayment Schedule for Top-tier Bonds		1	2	3	4	5	25	26	27	28	29	30
Opening Debt		856.00	809.61	763.15	716.56	655.83	0.00	0.00	0.00	0.00	0.00	0.00
Less: Repayment from Cash flow Analysis		46.39	46.47	46.58	60.73	61.10	0.00	0.00	0.00	0.00	0.00	0.00
Add: Defaulted Interest not paid		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Closing Balance	856.00	809.61	763.15	716.56	655.83	594.73	0.00	0.00	0.00	0.00	0.00	0.00
Interest Expense		29.96	28.34	26.71	25.08	22.95	0.00	0.00	0.00	0.00	0.00	0.00
Part 4: Cash Flow Watefall												
Interest Income		65.00	62.96	60.93	58.91	56.89	18.18	15.45	12.61	9.65	6.57	3.35
Add: Repayment		11.35	11.84	12.36	12.90	13.60	39.20	41.33	43.57	45.94	48.44	51.07
Add: Recoveries		FALSE	FALSE	FALSE	14.00	13.56	2.77	2.51	2.24	1.96	1.66	1.36
Net Cash Flow		76.35	74.80	73.29	85.81	84.06	60.15	59.29	58.42	57.55	56.67	55.78
Less: Interest Expense		29.96	28.34	26.71	25.08	22.95	0.00	0.00	0.00	0.00	0.00	0.00
Cash Flow for Debt Repayment		46.39	46.47	46.58	60.73	61.10	60.15	59.29	58.42	57.55	56.67	55.78
Repayment of Debt		46.39	46.47	46.58	60.73	61.10	0.00	0.00	0.00	0.00	0.00	0.00
Equity Payment		0.00	0.00	0.00	0.00	0.00	60.15	59.29	58.42	57.55	56.67	55.78

Figure 2.12 – Cash Inflows from Sub-prime Loans in Structured Finance Model

Once you build the model with these few sections, you can see the difficulties in construction a packaged security from subprime loans. If the equity investors are to receive a good return, there must be a big spread between the interest rate earned on subprime loans and the interest rate paid on the top-tier debt. If the interest rates on the sub-prime debt and the top-tier debt were similar, then there would be nothing left for equity holders. This means the top-tier bonds had to get a good credit rating. If there was a lot of equity put into the structured investment, the IRR for equity investors also declines. Using the model the structuring challenges are demonstrated. The interest income must cover (1) defaults from the subprime mortgages; (2) payment of fees; (3) debt service on top-tier debt and (4) payments to equity investors. The trouble is that the cash flow earned from subprime debt was not enough to go around to all of these parties.

More important than illustrating structuring difficulties in setting-up collateralized debt instruments, the simple model shows that the top-tier debt could not be classified as very low risk with almost no chance of default. For a loan to be rated AAA there would have to be virtually no chance that the loans could default. In terms of our model, this implies that no reasonable default probability and loss given default could result in the IRR on the top-tier debt being lower than the stated interest rate. Using a sensitivity tool in excel (the data table), defaults on the top-tier debt are illustrated in the Figure 2.13. The question raised

by this table is whether the scenarios that are shaded in the table are conceivable. If the credit rating is AAA, they do not have to be likely. For the top-tier debt to have a very high rating, the scenarios that are shaded would have to be virtually impossible.

Years of High Default 5.00

		Loss Given Default			
		30.00%	40%	50%	60%
	3.00%	3.50%	3.50%	3.50%	3.50%
	6.00%	3.50%	3.50%	3.50%	3.50%
	9.00%	3.50%	3.50%	3.50%	3.50%
Prob	12.00%	3.50%	3.50%	3.50%	3.50%
Default	15.00%	3.50%	3.50%	3.38%	2.82%
	18.00%	3.50%	3.50%	2.75%	2.10%
	21.00%	3.50%	3.09%	2.11%	1.36%
	24.00%	3.50%	2.58%	1.47%	0.61%
	27.00%	3.48%	2.07%	0.82%	-0.16%
	30.00%	3.11%	1.56%	0.17%	-0.94%

Figure 2.13 – Sensitivity Analysis on Top-tier IRR from Alternative Probability of Default and Loss Given Default Assumptions

Using the scenario analysis described above, the possibility of defaults on top-tier debt was not surprising. Given high loan to value statistics and large declines in the value of homes, it would be surprising if loans did not default. Further, again because of the possibility of declines in housing prices, the loss given default could be 60%. While this scenarios that are shaded may not have seemed highly likely before the financial crisis, the idea of an AAA bond rating was that it was virtually impossible. Default rates could not be simulated from historic data and people could not afford interest rates on the subprime mortgages. One could argue that the shaded areas were not only possible but likely outcomes. The bonds should not have been rated AAA and you do not need a really fancy model to demonstrate this fact. A simple model explains what the collateralized debt was not a viable financial security and it was not responsible to assign a high credit rating to this debt.